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ABSTRACT

Empiricists work with general concepts defined by their observed sets of objects. Their explanations involve their general concepts derived by trial and error from their untheoretical observations and experience. This paper distinguishes empirical educational research from scientific research to avoid confusion between the two. A reason for the success of science may be because science uses abstract concepts drawn from empirical phenomena rather than with general concepts. The empiricist's mistake is to ignore the abstract concepts of the theoretical level. Lavoisier's oxygen theory of combustion is provided as an example of a scientific endeavor, and a classroom observation study is provided as an example of an empirical education endeavor. Science often develops ideas from imaginative conceptual leaps to produce abstract concepts. Educational empiricists use general categories generalized from observables. (YP)

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AN IMPORTANT DIFFERENCE
BETWEEN SCIENTIFIC RESEARCH
AND
EMPIRICIST RESEARCH IN EDUCATION

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AN IMPORTANT DIFFERENCE BETWEEN SCIENTIFIC RESEARCH AND EMPIRICIST RESEARCH IN EDUCATION

JOHN H. CHAMBERS

EMPIRICIST ENDEAVORS

The builders of the Aztec temples, Hadrian's Wall and the Medieval cathedrals were empiricist not scientific. The same is true of the Chinese discoverers of the magnet, gunpowder and rockets, and of the classic swordmakers of Japan. These people worked with general concepts defined by their observed sets of objects, and their explanations were empiricist generalizations which involved these general concepts and were derived by trial and error from their untheoretical observations and experience. They embodied their generalizations in traditions, procedures, and rules of thumb, but they did not, as science does, imaginatively create and relate abstract concepts abstracted from their experience and then link such concepts isomorphically to the empirical world.

In Europe, Medieval masons and builders had a sort of "empiricist technology" which used general concepts and was again built up through trial and error, but they had no abstract concepts (the kinds of concept involved in the scientific theory which is the basis of modern scientific technology). They had craft wisdom and rule of thumb. Some medieval cathedrals and castles held, others fell down. The problem was that the builders could not calculate any of the stresses. The only guides and the only "explanations" such masons and builders had were empiricist generalizations; viz. that this sort of arch, at this approximate height and at about this width, using this kind of and similar mass of stone had been observed generally to hold in the past.

The powerful theories of mechanics, statics and dynamics with their interrelated concepts and laws, which would explain why the arches and vaults of Mediaeval castles and cathedrals held, which are applied in modern architecture and engineering, were not worked out until the interrelated abstract concepts were produced to help form the scientific theory underpinning the scientific revolution in physics of the seventeenth

and eighteenth centuries. Until such times, the knowledge upon which construction was based was necessarily empiricist not scientific. To this day, the same empiricist approaches apply with varying degrees of precision in most of what people do in everyday life.

Yet it has been precisely the confusion of such empiricist "technology" with real scientific technology which applies the theories and concomitant laws of science that has continually occurred in history textbooks and which continues to occur amongst intelligent laymen. The crucial point for the present paper, and the reason for the above examples is that for over one hundred years empirical educational researchers have been equally confused, and have been engaging in empiricist endeavors rather than (as has been claimed) practising scientific research.

EMPIRICAL EDUCATIONAL RESEARCH IS EMPIRICIST NOT SCIENTIFIC

One key reason (there may be others) that the applicability of the findings of empirical educational research has been continually restricted is that such educational researchers, despite their increasingly sophisticated statistical methods, have continually confused their empiricist general concepts and commonsense theory with abstract scientific concepts embedded in scientific theory.

The basic mistake occurs at the point where ideas are drawn from the empirical world. For while it is true that the abstract concepts of science are in some manner suggested by happenings in the empirical world and that they must be capable of isomorphic connection to that world, they are not themselves observed conceptions of that empirical world, i.e. they are not empiricist notions. Scientific concepts and explanations unlike empiricist concepts and explanations are not defined by reference to observation; they do not consist of categories of observables; on the contrary, observation in science is defined by reference to the abstract scientific concepts, theories and explanations. Scientific concepts and the laws and theories which relate them are concatenations of abstractions and unobservables, (usually) held together by the equally pure abstractions of mathematics involving the ratio scales through which they are made isomorphic to the empirical world.

An important reason why science has been much more successful than empiricist endeavors, has not been because the phenomena of science are any simpler, but because science has worked with abstract concepts drawn from empirical phenomena, rather

than with general concepts about it. And such abstract concepts can then be related to seemingly quite diverse empirical phenomena. Thus, rainbows, magnetic compasses, electrical generators and television sets ostensibly do not appear to have anything in common, but they can all be understood by way of electro-magnetic theory. The explanation of success is not that such electro-magnetic phenomena are any simpler than social or educational phenomena, but that brilliant conceptual insight has been able to produce concepts and relationships which when used make the phenomena seem more simple.

THE TYPE OF THOUGHT CONNECTION OMITTED BY EMPIRICIST EDUCATIONAL RESEARCH

As the Willers (1972) have pointed out, empiricist connection as exemplified in the connections of the above-described empiricist endeavors prior to the scientific revolution, is empirical or "sensible"; empiricist connection relates observable concept to observable concept-- the falling snow is making the ground muddy; the white billiard ball striking the blue billiard ball causes the blue to move. In contrast, the rational connection of mathematics relates abstract concept to abstract concept-- $345 \times 543 = 187335$; $(a + b)^2 = a^2 + 2ab + b^2$. Science makes use of both these kinds of connection: But science also makes use of abstractive connection, which straddles the rational and the empiricist, and reciprocally relates abstract concept to the observed empirical world, for instance in, $\text{force} = \text{mass} \times \text{acceleration}$, as applied in calculating wind stresses; or in $2\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{HCl}$, as applied in the production of hydrochloric acid. On this account, the observed relations and events of ordinary life are empiricist or sensible: falling snow producing muddy soil; billiard ball moving billiard ball. In important contrast, the scientific relations and events of physics, chemistry, and the established sciences are abstractive: they use scientific theory to account for and predict observable happenings in the empirical world. Science has become powerful both in theory and in technological application as such scientific giants as Galileo, Snell, Hooke, Huygens, Newton, Lavoisier, Darwin, Wegener, Crick and Watson, and others have established such isomorphism. The key empiricist mistake is to be ignorant of and thus to ignore and omit the abstract concepts of the theoretical level. Both science and empiricist activity are tied or connected to the empirical world, but the tie or connection is different.

Empiricist knowledge is gained through generalizing sensation and experience. The empiricist connection of empiricist knowledge such as in empiricist educational

research connects observables but omits the theoretical and abstract level.

AN EXAMPLE OF SCIENTIFIC ENDEAVOR

The giants of the scientific revolution were successful because they were not empiricist. To do their work, these scientists had to step outside the world of empirical observation, to make conceptual and theoretical leaps to the abstract level. Take Lavoisier as an example. He did not produce his chemical revolution merely by careful observation, but by rejecting the phlogiston theory and (taking many years) conceptualizing an entirely new oxygen theory of combustion. After conceptualization and careful quantitative experiment, he asserted that combustion is a matter of combination of substances not a dissociation. His explanation was the exact opposite of that of the then current observationally-based one, and had massive implications. Lavoisier came to understand that it was not air as such but another X which was involved in combustion. This, together with the rejection of phlogiston theory (and thus the need for an entirely new explanatory theory) was the true revolutionary move. This search took him the next five years, on the way continuing to use his quantitative methods and to produce the first true chemical equation. And the search was not easy. For he was encountering what we might call the paradox of chemical discovery, viz. that, "Chemical analysis depends intimately upon the purity and identity of the substances under investigation. On the other hand, the purity and identity of the substances depends necessarily upon the correctness of the chemical analysis"(Gale, 1979, p.140). The abstract concepts of "element", "mixture" and "compound" had not yet been conceptualized. For they could not be, such conceptions having to wait upon the very conceptual and quantitative work Lavoisier was himself slowly sorting out. Finally he achieved isomorphism between his abstracted concepts of "oxygen" and "combustion", oxygen's specific relationship with mercury, between the theory in which oxygen and combustion were embedded, and the various effects of oxygen in the empirical world--such as its quantifiable proportions, and its combination with mercury to form mercuric oxide. Fundamentally we should notice how the rejected phlogiston view, as Butterfield says, ". was based upon one of those fundamental conclusions of commonsense [empiricist] observation which may set the whole of men's thinking on the wrong track,"(1958, p.194).

AN EXAMPLE OF EMPIRICIST ENDEAVOR: PROCESS-PRODUCT RESEARCH ON TEACHING

Process-Product research, the most popular of all the varieties of empiricist research in education (and commonly the model for empirical work in many other areas of education) is a cluster of observational-statistical and experimental-statistical approaches to research on teaching, which has been conducted in the last two decades in the United States, Australasia and Europe.

The recent work of Helmke and Schrader in Germany published in the *Journal of Educational Research* in 1988 may be taken as typical. They studied thirty-nine Grade V teachers and their classes in twenty-four Bavarian primary schools, (19 men, 20 women). (Their survey of a random sample of 651 other German teachers, showed no significant differences between the thirty-nine and their sample thirty-nine.) Their research compared independent mathematics practice by pupils with mathematics practice guided by teachers. As an empiricist nod in the direction of theory, they say that previous research had suggested that the following conditions were characteristic of effective practice: First there are established management routines. "The teachers monitor the class thoroughly and intervene immediately in the case of disruptions," (1988, p.70), that teachers have clearly shown the children know what is expected of them, that children are intensively supervised, that teachers inspect students' work frequently, but contacts are normally brief, ". usually not longer than 30 seconds" (p.71). Because they were not dealing with a random sample of classes, the researchers were faced with the problem of statistically equalizing the entry abilities of the pupils (p.72).

The teachers were observed by way of a low-inference system (Five Minute Interaction system) which was a modification of Stallings's Multiple Coding system. Observations were taken during nine lessons by each teacher. "Coding was based on a combined time and event sampling that allowed every new event to be coded. When the event lasted longer than five seconds, coding was repeated every five seconds," (1988, p.72). The concepts with which they worked were as described follow:

Seatwork refers to an instructional context in which students work independently at written tasks and exercises. . *Monitoring* refers to supervision of students' work by the teacher without interacting with students. *Discreet support* comprises all subject-related teacher contacts with individual students during seatwork, eg. diagnosing errors. . answering students' questions. .

Public interactions comprise all teacher utterances directed to single students that

are given indiscreetly and are consequently heard by the whole class.

Lecturing refers to teacher presentation or explanation of academic material.

Recall questions are questions that require recall or recognition of factual information rather than higher level processing.

Disciplinary events are all interactions dealing with student misbehavior.

Procedural activities are all comments concerning nonacademic procedures and organizational activities (1988, p.72).

It is clear that none of the above involves abstract concepts, but rather, general, empiricist concepts defined by observables, not deriving any of their meaning from scientific theory.

Helmke and Schrader found that pupils' achievement was highest when both the frequency of teachers' supportive contacts with students and their diagnostic competence were above average. They claim that a surprising result was that those classrooms whose teachers who were good diagnosticians, yet who gave their students comparatively little support, showed pronounced decline in achievement, writing, "Such students may become sensitized to their own weaknesses but do not receive sufficient support in overcoming these weaknesses." They write, ".our results show, the mere quality of seatwork is unrelated to academic success. That is, the amount of independent student practice in the context of seatwork has no impact on achievement" (1988, p.74).

They are impressed by the following, "According to our data, it is not the quantity but the quality of independent student practice that makes a difference." They point out that, "The organization of independent student practice by less successful teachers (with regard to the achievement gain of their classroom) is characterized by frequent interruptions through lecturing and questions." This, they claim, ".coincides with the results reported by Fisher and others (1978) and illustrates that independent practice characterized by either insufficient preparation or inappropriate task difficulty level undermines achievement" (1988, p.74).

The researchers also found evidence which supported the importance of having a smoothly running classroom. They produced significant negative correlations between achievement and the frequency of disciplining and explaining procedures. They further consider that three conditions were especially important: an adequate context, continuity of the seatwork, and discrete monitoring of each student (1988, p.74).

Over the last two decades there have been hundreds of such empiricist studies.

TWO BROAD KINDS OF CONCEPT

In stark contrast to scientific concepts (eg. of oxygen chemistry), the concepts of empiricist educational research of the Helmke and Schrader sort cannot be mathematically related, but are statistically related. Scientific research is abstract, but precise. Empiricist research in education is general and approximate. For instance Helmke and Schrader in the above study used such concepts as "seatwork", "monitoring", "recall question", and so on; these are very different from "oxygen", "combustion", "mass", "electron", "volt", "acid", "magnetic field", "tectonic plate", and so on. The former are merely general categories generalized from observables, which gain their meaning from such clusters of observables. The latter have as their origin imaginative conceptualization and painstaking discovery.

One of the features which help make science science is its ability to make use of ratio measures such as metres, grams, seconds, seconds per second, Newtons, Volts, and so on. But carefully to be noted is the fact that in science this use of ratio measures occurs in the abstractive relationship between the abstract concepts of theory and the empirical world, i.e ratio measures are used in providing the isomorphisms between the theory with its embedded abstract concepts and the empirical world. The general point is that ratio measures cannot be used with integrity until there exist abstract concepts at the theoretical level.

CONCLUSION

Even if there is a natural history observational stage at the beginning of a particular science, natural history and careful observation do not make science. Science does not arise from ever more careful observations, or inductive generalization from these, but from imaginative conceptual leaps to produce abstract concepts. Such moves have not yet occurred in empiricist educational research. Let us hope that they will soon begin to be made.

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